Description

Method for reduction of the power consumption of a mobile data
memory; application of the method to an identification system
5   with at least one read/write device and a mobile data memory

The invention relates to a method for reducing the power
consumption of a mobile data memory for contactless data
transmission with a read/write device. The invention further
10 relates to a mobile data memory and an identification system
including at least one read/write device and a mobile data
memory.

In the prior art, identification systems are known which
15 include one or more stationary read/write devices which
exchange data in a contactless manner with mobile data memories
via a data transmission link which usually is radio-based.
Systems of this type are used in technical installations in
which a large number of objects or commodities must be moved as
20 quickly and freely as possible. The objects may be of various
types, e.g. packages in a dispatch installation, assembly parts
in a manufacturing plant, items of baggage in a transportation
system, etc.

25 An example of an identification system of this kind is
described in the ISO-18000-4-MOD3 standard entitled "Radio-
Frequency Identification Standard for Item Management - Air
Interface".

30 The standard provides that polling for the presence of a mobile
data memory in the detection range is carried out by the
read/write device. For this purpose the read/write device emits
an unmodulated carrier signal with a predefinable backscatter

frequency of, for example, 2.45 GHz. The signal can be returned to the read/write device passively, e.g. by backscattering, by a mobile data memory located within the reception range.

5 Independently thereof, the mobile data memory modulates the impedance of an integrated transmit/receive antenna in cyclical sequences with a significant recognition sequence to identify the mobile data memory to a read/write device. In addition, the read/write device receives time information as to when the

10 mobile data memory will switch on its data receiver. If the read/write device can receive the returned modulated backscatter frequency, the validity of the reply is checked. If it is found to be valid, the read/write device applies a data modulated carrier signal at the time when the mobile data

15 memory is expected to be ready for receiving. This signal contains, firstly, the unmodulated backscatter frequency and, secondly, a data modulated communication frequency which signals to the mobile data memory that a data transmission will now follow. The transmitted data may contain, for example, an

20 identification number of the read/write device. By means of this identification number it can be determined, for example, whether the data awaiting transmission is intended for the mobile data memory or not. For the mobile data memory this means that valid or invalid data is to be sent. The mobile data

25 memory can also classify as invalid data already transmitted during a data reception, if inconsistencies, e.g. through transmission errors, are recognized.

A signal received by the receive antenna of the mobile data

30 memory is now polled cyclically and at short intervals for a presence of the data modulated carrier signal, i.e. for a simultaneous presence of the backscatter frequency and the data modulated communication frequency. If both frequencies are

detected, the data receiver of the mobile data memory remains
switched on to receive data.

For its power supply the mobile data memory usually has an
5   energy store, in particular a battery. To achieve the longest
possible operating life, therefore, it is necessary to minimize
the power consumption. A known measure for reducing power
consumption is, for example, to select especially power-saving
electronic components. In addition, the circuit design of a
10   mobile data memory should take account of the fact that many
times more current is required to receive data than to transmit
data. Unlike the very low power requirement for the passive
backscattering described in the introduction, for which the
antenna impedance is modulated only momentarily, several
15   circuits must be connected for data reception. In addition,
these circuits, such as data demodulator, amplifier, mixer,
etc., require a minimum time until transients have subsided and
the components are ready for operation. Moreover, account
should be taken of the fact that in operational use data is
20   generally transmitted between read/write device and mobile data
memory only for fractions of the total operating time. It is
therefore recommended in the above-mentioned standard that the
data receiver of the mobile data memory be switched on only
cyclically and for a short period to reduce power consumption.
25

To achieve data reception at a data rate of 384 Kbit/s
according to the above-mentioned standard, at least double the
reception clock frequency of 384 kHz is required to be able to
sample a received signal before demodulation. Frequently,
30   however, oversampling of the incoming signal is essential in
order to achieve a more reliable reading of the data. In that
case a possible clock frequency would be, for example, four or
eight times the above-mentioned required data rate. This would

correspond to a clock frequency of 1536 MHz or 3072 MHz respectively. From this clock frequency the data rate of 76.8 Kbit/s laid down for cyclical transmission operation by the standard can be derived by means of dividers connected to the

5   output. But even with the exemplary clock frequency of 1538 MHz, which still yields satisfactory values for data reception, the mean power consumption of the associated quartz oscillator is approximately 20 to 30 µA.

10 Despite all the aforementioned measures it has not been possible up to now to minimize power consumption to the extent that a battery exchange during the life of the mobile data memory can be dispensed with. This has the associated disadvantage that with an exhausted battery the data stored in

15 the mobile data memory can be lost.

A further disadvantage is that to exchange the battery in time, the mobile data memory must, for example, be withdrawn from the production process. This can cause delays and interference in

20 the process flow. Depending on the case and the field of application, the required life of a mobile data memory can be approximately 10 to 15 years.

It is the object of the invention to provide a method and a

25 mobile data memory by which the service life of the mobile data memory can be increased.

This object is achieved according to the invention with a method for reducing the power consumption of a mobile data

30 memory for contactless data transmission with a read/write device having the features of claim 1.

According to the method, the mobile data memory, which contains

at least one energy store and consumers, is supplied with a
first clock frequency from a first oscillator at least for a
cyclic inactive idle mode, and with a second, higher clock
frequency from a second oscillator for data reception at least
5   during a cyclic polling time. The higher clock frequency is
intended primarily for data modulation of a received signal
obtained from the receive antenna or from a combined
transmit/receive antenna of the mobile data memory.

10   The lower clock frequency, by contrast, serves primarily for
internal timing, for example, to supply a "sleep timer", and to
transmit data.

This has the advantage that the second clock frequency of the
15   second oscillator, which has higher power consumption, is
switched on only during a brief polling time in which it is
checked whether a read/write device is located in the
environment of the mobile data memory.

20   The mean power consumption of the mobile data memory can
thereby be considerably reduced.

In a further embodiment of the method the second clock
frequency is a multiple. As a result, the clock dependent
25   circuit parts can be synchronized with one another for internal
timing when transmitting and receiving data.

In an advantageous embodiment of the method the second clock
frequency is at least 5 times and preferably 40 times the first
30   clock frequency.

The advantage of a second clock frequency which is very high in
comparison to the first clock frequency is that the transient

period of the associated oscillator is only a fraction of that of the oscillator for the first clock frequency.

In a preferred embodiment of the method, a level of the
5 received signal is measured within the cyclic polling time and the received signal is then data demodulated if a minimum level is present. With this arrangement the second oscillator can advantageously be switched off again if a minimum level is not present. Polling for the presence of a communication-ready
10 read/write device by means of level detection requires only a fraction of the supply current which is needed, in comparison, for a complete data demodulation.

This advantageously makes possible a further considerable
15 reduction in the mean power consumption of the mobile data memory and therefore an increase in the total service life of the mobile data memory.

As a result, the battery advantageously no longer needs to be
20 exchanged during the whole service life of the mobile data memory. The logistic effort to search for and remove the mobile data memory from, for example, a manufacturing or automation process is therefore advantageously no longer necessary. Possible interference with process flows can thereby be
25 advantageously avoided.

A further advantage is that stored data cannot be lost through an exhausted battery, for example, as a result of failure to exchange the battery in time.
30

In a further embodiment the data demodulation of the received signal is ended if the demodulated read data is invalid. If that is the case the second clock frequency can be switched off

again.

In a preferred embodiment of the method the second clock
frequency is switched on for an initial transient period at the
5   start of the polling time and before the data demodulation of
the received signal. The transient or switch-on period of the
data demodulator and of the other circuit parts of the data
receiver is negligible in comparison to the transient period of
the oscillator. As a result, these circuit parts with high
10   energy consumption can advantageously be switched on only at
the end of the transient period of the oscillator.

The method can advantageously be employed in an identification
system based on the ISO/IEC 18000 standard for operation in an
15   ISM frequency band, in particular an ISM frequency band of 2.45
GHz. In particular, the data reception of a mobile data memory
takes place in an S1 timeslot according to the standard.

The object of the invention is further achieved according to
20   the invention with a mobile data memory for transmitting data
to a read/write device having the features of claim 13.

To transmit data to a read/write device the mobile data memory
has at least one antenna, a data receiver and data transmitter
25   connected thereto, an energy store for power supply, a first
oscillator with a first clock frequency, in particular for a
timer and for the data transmitter of the data memory, and a
second oscillator with a second, higher clock frequency, in
particular for the data receiver. In addition, the data memory
30   has a control unit, e.g. a microcontroller or the like, which
intermittently connects circuit parts of the data memory to the
energy store and which connects the second oscillator to the
energy store at least during a cyclic polling time.

In one embodiment the data receiver includes a data demodulator
for data demodulation of a received signal from the antenna.
The data modulator is connectable from the control unit to the
5   energy store.

In a further embodiment the data receiver includes a level
detector for measuring the level of the received signal. The
level detector is connectable from the control unit to the
10 energy store.

For the time-controlled switching on and off of the above-
mentioned electronic circuit parts of the mobile data memory,
such as the data transmitter, level detector, amplifier and
15 mixer of the data demodulator, the data memory has a clock or
timer together with electronic switching means which can be
activated, in particular by the control unit. The clock may be
in the form, for example, of internal registers in the
microcontroller. In addition, the electronic switching means,
20 e.g. transistors may, for example, be integrated in the
microcontroller as outputs of an output port.

In a preferred embodiment the oscillators are quartz
oscillators, which can advantageously supply an extremely
25 stable clock frequency as integrated electronic components.

A plurality of the aforementioned mobile data memories,
together with one or more associated read/write devices, form a
mutually attuned identification system.
30

This is explained more detail with reference to the following
figures, in which:

Fig. 1   shows an exemplary structure of a mobile data memory
             with two oscillators according to the invention, and

Fig. 2   shows an exemplary power consumption curve of the
5   inventive variant of the mobile data memory of Fig.
             1.

Fig. 1 shows an exemplary structure of a mobile data memory DT
which can exchange data with a read/write device SLG via an air
10   interface LS. Write data sent by the mobile data memory DT is
denoted by SDAT, and read data SLG from the read/write device
SLG is denoted by RDAT. The read/write device SLG forms an
identification system IS with at least one mobile data memory
DT.
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For data transmission with the read/write device SLG the mobile
data memory DT includes transmit and receive antennas SA,EA. In
the example of the Figure respective antennas EA,SA configured
for this purpose are used for transmitting and receiving the
20   data RDAT,SDAT. Correspondingly, a data transmitter SEND and a
data receiver EMP are connected respectively to the antennas
SA,EA. In addition, the mobile data memory DT includes a
control unit C as an electronic data processing unit which
transmits the data SDAT to be sent in digital form via an
25   exemplary transmission data line SD, e.g. a data bus, to the
data transmitter SEND. The data transmitter SEND may be
configured for active or passive operation. The passively
operating embodiment based on the backscattering method
mentioned in the introduction advantageously has especially low
30   power consumption. In the opposite direction, the control unit
C receives the read data RDAT in a corresponding manner from
the data receiver EMP. A received signal ES coming from the
receive antenna SA is demodulated and prepared in digital form.

For this purpose the data receiver EMP has a data demodulator
DM, e.g. for intermediate frequency demodulation of the
received signal ES, and a level detector PD. The received
signal ES may optionally be pre-amplified. Via an exemplary
5   bidirectional memory data line MD, the control unit C stores or
unloads the optionally prepared read data RDAT, or the
optionally to be prepared write data SDAT, respectively in or
from an electronic memory MEM. This may be, for example, a
static memory SRAM, an EEPROM or a FRAM memory.
10

For its energy supply the mobile data memory DT includes an
energy store BAT, e.g. a lithium battery. A part of the
electronic circuitry, e.g. a volatile electronic memory MEM or
timer modules, is connected permanently to the energy store
15   BAT, for example, to maintain the content of the electronic
memory MEM. Electronic circuits with high power consumption,
e.g. the data demodulator DM, amplifier, HF mixer, etc., may be
connected to the energy store BAT by means of electronically
activatable switching means S1-S2, e.g. switching transistors.
20   In that case, to reduce power consumption all the circuits
necessary for data reception are switched on cyclically to poll
for the presence of a read/write device SLG. The switching
means S1-S2 may be already integrated in the exemplary control
unit C. It is also possible to use, for example, output
25   channels of the control unit C directly to supply electronic
circuits with energy.

In the example of the present Figure the associated currents
IB,IR,IDM,IPD,If1 are marked. IB is the total supply current
30   which is provided by the energy store BAT. IR denotes the idle
current which results from the sum of the idle currents of all
the electronic components of the mobile data memory DT. This
idle current IR is usually a few µA. IDM denotes the supply

current of the data demodulator DM, while IPD denotes the supply current of the level detector PD. The current consumption IP of the level detector PD, however, is greater than the idle current by a factor of approximately 100. If all the components of the data receiver EMP are additionally switched on for a data reception, in particular the data demodulator DM, the total power consumption can be increased by a further factor of 10 to 20.

According to the invention, the mobile data memory DT now has two quartz oscillators Q1,Q2 with a first and a second clock frequency f1,f2, instead of one oscillator as a basis for the transmission and reception timing.

If1 denotes the supply current If1 of the first oscillator Q1, which provides a first clock frequency f1 for the mobile data memory DT. The first clock frequency f1 is intended primarily for a sleep timer, which switches the mobile data memory DT cyclically to the active transmission and/or reception mode. At the same time, the transmission clock pulse for transmission of the data SDAT is derived directly from this first clock frequency f1. Consequently, the first oscillator Q1 is connected permanently to the battery BAT and therefore generates the first clock frequency f1 continuously. From the latter frequency further, lower clock frequencies for internal timing of the integrated electronic circuits may be derived, for example, by means of divider or counter modules not further described. The first clock frequency f1 is, for example, only 153.6 kHz, to provide which the first oscillator Q1 advantageously requires a power consumption of only approximately 2 to 3 µA. Here, the principle applies broadly that the generated clock frequency and the power consumption of an oscillator are approximately proportional to one another.

Furthermore, the above-mentioned idle current IR and this
supply current If1 form a mean total current IR,If1 of the
mobile data memory DT, which is established in the inactive
idle mode. In total, this current IR,If1 amounts to a few µA.

5

The second oscillator Q2 now generates the second clock
frequency f2 which, in comparison to the first clock frequency
f1, is a multiple thereof. In the example shown in the Figures,
40 times the first clock frequency f1, i.e. a clock frequency

10 of 6144 MHz, is used. The current If2 needed for its generation
by the second oscillator Q2 is approximately 100 µA. However,
because, according to the invention, the second oscillator Q2
is switched on cyclically, and then only for very short
periods, for data demodulation of the received signal ES, and

15 taking account of the fact that in operational use a data
transmission between read/write device and mobile data memory
generally takes place in fractions of the total operating time,
a considerably smaller portion of the current is advantageously
established as the mean current consumption for clock pulse

20 generation, in comparison to the solution according to the
prior art.

The advantage of the second clock frequency f2, which is very
high in comparison to the data reception rate, is that multiple

25 oversampling is possible - 16 times in the example shown in the
Figure - so that very high reception quality is achieved. In
addition, it is an advantage that the quartz oscillator Q2
reaches its steady state without transients considerably more
quickly after the supply voltage has been switched on than an

30 oscillator with a comparatively low clock frequency.

Fig. 2 shows an exemplary power consumption curve VI of the
variant of the mobile data memory DT according to the invention

shown in Fig. 1, the current value IB of which is plotted on a
time axis t. Particular time points on the time axis t are
denoted by t1 and t6. Because of the quantitatively very
different values for the idle current IR, the supply currents
5   If1,If2 of the two oscillators Q1,Q2, of the level detector
current IPD and the current IDM of the data demodulator DM in
the data receiver EMP, only a qualitative representation is
possible. If1 and IR are entered as a common value. Both
currents If1,IR are quantitatively approximately equal and are
10 negligible in relation to the other, much larger currents. For
these current values of the power consumption curve VI, the
mobile data memory DT is in the inactive idle mode. To poll for
the presence of a read/write device SLG the system is switched
to the ready mode for data reception for only a short cyclic
15 polling time TA, triggered by the sleep timer TIMER. T denotes
the cycle time which is established for the usually
unsuccessful polling for the presence of a read/write device
SLG. The relation between cycle time T and polling time TA
should be seen only as an example and - depending on the
20 configuration of the mobile data memory DT - may be a multiple
thereof, i.e. 10 to 100 times.

According to the invention, the second oscillator Q2 is
switched on during a polling time TA. This can be seen in a
25 sudden increase in the total current requirement IB of the
mobile data memory DT at the time points t1 and t5. In
addition, the second oscillator Q2 is switched on with an
advance time TV - calculated from the start of the polling time
TA - before, according to the invention, a level detector PD is
30 switched on once transients in the second oscillator Q2 have
subsided. The level detector PD then checks for a brief period
t2-t3 whether the characteristic frequencies emitted by a
communication-ready read/write device SLG according to the

above-mentioned standard are present, and whether a minimum
level of an intermediate frequency formed from these two
frequencies by means of intermediate frequency demodulation is
present. If this is the case, the data demodulator DM with the
5   high-consumption components such as mixer, HF pre-amplifier,
etc., having a power requirement of a few mA, is switched on
for complete data demodulation. When a valid data transmission
has been completed, or invalid data has been recognized, the
mobile data memory DT reverts to the inactive idle mode at the
10   time point t6.